Physics 311

Homework Set 5

1. Find the electric field a distance s from an infinitely long straight wire, which carries a uniform line charge λ.

2. Find the electric field inside a sphere which carries a charge density of the form

$$\rho(r) = kr^{\pi} \tag{1}$$

for some constant k. *Hint:* This charge density is *not* uniform, and you must *integrate* to get the enclosed charge.

3. A hollow spherical shell carries charge density

$$\rho(r) = kr^{\pi} \tag{2}$$

for some constant k in the region $a \leq r \leq b$ (Fig. 2.25).

Find the electric field in the three regions:

a) $r < a$.

b) $a < r < b$.

c) $r > b$.

4. A long coaxial cable (Fig. 2.26) carries a *volume* charge density

$$\rho(s) = \rho_0 \frac{s}{a} \tag{3}$$

on the inner cylinder (radius a), and a *uniform surface* charge density on the outer cylindrical shell (radius b). This surface charge is negative and of just the right magnitude so that the cable as a whole is electrically neutral.

Find the electric field in each of the three regions

a) $s < a$.

b) $a < s < b$.

c) outside the cable ($s > b$).

d) Plot $|\vec{E}|$ as a function of s.

5. One of these is an impossible electrostatic field. Which one?

a) $\vec{E} = k\,[x^2 y\ \hat{x} + 3yz^2\ \hat{y} + 2xz^3\ \hat{z}]$

b) $\vec{E} = k\,[3y^2\ \hat{x} + (6xy + 3z^2)\ \hat{y} + 6yz\ \hat{z}]$.

Here k is a constant with the appropriate units. For the *possible* one, find the potential, using the *origin* as your reference point. Check your answer by computing $\vec{\nabla} V$.

[*Hint*: You must select a specific path to integrate along. It doesn't matter *what* path you choose, since the answer is path-independent, but you simply cannot integrate unless you have a particular path in mind.]